

EXECUTIVE SUMMARY

The Environmental Management Science Program (EMSP) was established by Congress in 1996 under the Department of Energy (DOE) Environmental Management (EM) Office of Science and Technology to “develop and fund a targeted long-term basic research program that will result in transformational or breakthrough approaches for solving the Department’s environmental problems.” The EMSP is a partnership between the Department of Energy (DOE) Office of Basic and Applied Research and the Office of Science, and funds competitively awarded research that seeks scientific understanding leading to reduced remediation risks, costs, or schedules, and helping to solve currently intractable problems. As such, EMSP supports research that leads directly to the fulfillment of the following EMSP research objectives:

- Provide scientific knowledge that will revolutionize technologies and clean-up approaches to significantly reduce future costs, schedules, and risks
- “Bridge the gap” between broad fundamental research that has wide-ranging applicability such as that performed in DOE’s Office of Science and needs-driven applied technology development that is conducted in EM’s Office of Science and Technology
- Focus the nation’s science infrastructure on critical DOE environmental management problems.

The intent of this *EMSP Research Accomplishments Summary* is to provide information concerning varied research transition activities. Research transitions are measures of how successfully the program has transitioned knowledge gained from research projects to other areas. These measures may be in the form of actual transfers of new knowledge or data gained through research products or processes to other areas within EM, such as Focus Areas and Crosscutting Programs, or may be more general knowledge transfer measures found in similar research programs, such as collaborations, numbers of student researchers, peer reviewed papers and presentations (communication products), or consultations.

Since 1996, the EMSP has funded over 300 basic research projects at 90 universities, 13 national laboratories, and 22 other governmental and private laboratories in 39 states and 7 countries. Many of these projects have generated sufficient technical data and identified specific, potential field applications to warrant movement into the applied R&D arena. Research accomplishments from EMSP-funded projects, with total quantities in each category as follows:

• <u>Collaborations</u>	<u>Total</u>
Consulting - provide advice or technical expertise	46
Joint interaction - researcher/end-user in joint interaction	49
Mission directed - project direction provided by end-user	19
Program interaction - researcher to researcher interaction	60

• <u>Student Researchers</u>	<u>Total</u>
Undergraduate Researchers	103
Master Researchers	260
Ph.D. Researchers	69
Post Doctoral Researchers	184
• <u>Research Transfers</u>	<u>Total</u>
Commercializations	13
Deployments	10
Field Tests	15
Focus Areas & Crosscutting Programs	3
Processes	2

The information presented in this document is an attempt to capture research transition activities as of October 31, 2001, and therefore should not be considered to be a complete or accurate listing. Research publications and other communications products for EMSP-funded projects are documented in *Communication Products for the Environmental Management Science Program*.

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RESEARCH ACCOMPLISHMENTS FOR THE ENVIRONMENTAL MANAGEMENT SCIENCE PROGRAM

INTRODUCTION

The Environmental Management Science Program (EMSP) is a partnership between the Department of Energy (DOE) Office of Basic and Applied Research and the Office of Science. The mission of the EMSP is to develop and fund a targeted long-term basic research program that will result in transformational or breakthrough approaches for solving the Department's environmental problems. The EMSP funds competitively awarded research that seeks scientific understanding leading to reduced remediation risks, costs, or schedules, and helping to solve currently intractable problems. The sites will use the understanding gained through EMSP-supported research to improve their cleanup efforts. Implementing these approaches will lead to reductions in cleanup costs, as well as reductions in risks to workers and the public. The Environmental Management Science Program (EMSP) has funded over 300 basic research projects at 90 universities, 13 national laboratories, and 22 other governmental and private laboratories in 39 states and 7 countries.

Many EMSP projects have generated sufficient technical data and identified specific, potential field applications to warrant movement into the applied R&D arena. Based on the technical strength of his work for Project #81897 (renewal of #64535), *Millimeter-Wave Measurements of High Level and Low Activity Glass Melts*, Dr. Paul P. Woskov, Massachusetts Institute of Technology, has received an R&D 100 Award for the creation of a new device that uses coherent millimeter waves to measure the viscosity of high temperature melts. Viscosity is an important property in the creation of high-level and low activity glass waste forms. This device has a greater viscosity measurement range than its competitors, is more accurate, and can withstand higher temperatures. It has a broad range of applications in non-EM Programs as well (see cover photo).

The information contained in this document has been gathered from various sources, such as interactions with EMSP staff, proceedings from EMSP workshops and technical conferences, principal investigators, the Project Tracking System, EMSP Project Annual Reports, and literature searches. The information presented is an attempt to capture research transition activities and therefore should not be considered to be a complete or accurate listing. This document contains the best available data as of October 31, 2001.

Problem Areas Addressed by EMSP Research

The EMSP focuses on the key EM problem areas defined in the *EM Research and Development Program Plan*. These problem areas are grouped by waste area, representing the scope of cleanup facing EM. These areas are the basis for developing science and technology investments. The focus areas link both research and technology development to these eight problem areas:

- Deactivation and Decommissioning research advances science to solve environmental problems associated with placing equipment and structures in a desired end state. Desired end states include complete removal and remediation of the facility, release of the facility for unrestricted use, or release of the facility for restricted use.
 - High-Level Waste research advances science to solve environmental problems associated with storage tanks containing highly radioactive wastes, which include organic and inorganic chemical compounds in solid, colloidal, slurry, and liquid phases.
 - Mixed Low-Level Waste (MLLW) /Transuranic Waste (TRU) research advances science to solve environmental problems associated with very limited treatment options and disposal capacities.
 - Nuclear Materials research advances science to solve environmental problems associated with unstable materials, such as plutonium metals and oxides, highly enriched uranium and nuclides of other actinide elements, and the long-term storage of stabilized materials.
 - Spent Nuclear Fuel research advances science to solve environmental problems associated with safely and efficiently managing spent nuclear fuel from both domestic and foreign reactors.
 - Subsurface Contamination research can assist the Department in solving environmental problems associated with hazardous and radioactive contaminants in soil and groundwater that exist throughout the DOE complex, including radionuclides, heavy metals, and dense, nonaqueous phase liquids.
 - Health, Ecology, and Risk is a crosscutting problem area; therefore, the research investment will impact cleanup work across the Department of Energy (DOE) complex. There is scientific uncertainty about the levels of risk to human health and the environment at the end stages of the DOE cleanup effort. Accurate risk analyses require thorough knowledge of contaminant characteristics, basic ecological processes and principles, rates at which contaminants move through ecosystems, and health and ecological effects. In particular, better knowledge of radionuclide and toxic chemical transport dynamics and the potential effects of long-term exposure to low levels of radionuclides, in combination with other contaminants, is needed to assist the DOE in its efforts to protect the public, workers, and the environment. This research would also improve the understanding of threatened and damaged ecosystems and processes to restore their viability and quality.
 - Long-Term Stewardship research supports issues that impact the Department in assessing site conditions after a site is closed and a remedy has been implemented. Long-term stewardship research is necessary to support the Department's commitment to protect human health and the environment after site closure for sites where cleanup to levels acceptable for unrestricted use is not possible.
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Science Categories

EMSP research is classified further within each problem area based upon the type of science being conducted. Science classifications include the following:

- Actinide Chemistry including uranium, americium, and plutonium
- Analytical Chemistry and Instrumentation includes sensor development and diagnostics such as non-destructive examination
- Biogeochemistry studies such as oxidation/reduction and biological degradation
- Engineering Science research such as robotics and remote sensing
- Geochemistry that focuses on reactions within the subsurface
- Geophysics that included advanced characterization methods
- Health Science research on dose assessment, bio-markers, and risk estimates
- Hydrogeology that targets subsurface transport mechanisms and predictive modeling
- Inorganic Chemistry including tank waste speciation and metals remediation
- Low Dose Radiation to understand the health effects of low doses of radiation
- Materials Science which studies phenomena such as corrosion, glasses and other waste forms
- Microbial Science research on areas such as bio-remediation and microbial transport
- Plant Science area such as phytoremediation
- Separations Chemistry that focuses on high level tank waste treatment alternatives.

DOCUMENT LAYOUT

Research transition activities are addressed in three accomplishments categories: collaborations, research transfers, and student research. In addition, this volume contains sections covering success posters, fact sheets, and workshops sponsored by the EMSP. Project publications are documented in *Communication Products for the Environmental Management Science Program*.

1. *Success Posters*. These highlight several projects that are examples of EMSP research being integrated into EM cleanup. Some of these projects have been deployed at DOE sites to support cleanup while others are still in the maturation process but are closely linked to site needs.
2. *Fact Sheets*. These are summaries of EMSP projects or groups of projects linked to specific problem areas within EM. The fact sheets highlight program efforts to support EM cleanup.
3. *Collaborations*. This section reports the collaborative effort being undertaken by EMSP projects to further research and to transfer research towards technical maturity. To date, 159 collaborations have been reported.

4. *Research Transfers.* The main objective of EMSP-funded research is to address EM clean-up needs through 2070. This section highlights 32 research transfers (i.e., deployments, products, spin-off business, field tests, continuation by others, etc.) by project. Some activities listed in this section may be planned actions and are provided to ensure follow-up contacts are made.
5. *Graduate Students.* One of the two main objectives of the EMSP is to develop a cadre of environmental scientists to meet 21st century clean-up needs. This section tracks the impact the EMSP is having on increasing the cadre of environmental researchers. The number of Post Doctoral, PhD, Masters, and Undergraduate students are reported by EMSP project. Graduate student researcher's names are noted where provided. As of March 30, 2001, 525 undergraduate, graduate, and post graduate researchers are funded under this program.
6. *Topical Workshops.* This is an overview of the various workshops sponsored by the EMSP to promote research integration and transfer. This includes the EMSP National Workshops, site-specific workshops focusing on a specific site such as the one hosted by the Idaho National Engineering and Environmental Laboratory (INEEL), and topical workshops such as the vadose zone series of workshops held at Hanford or the long term monitoring workshop held at INEEL.

EMSP-funded research activities are listed within each section by EMSP Problem Area and Science Category, and include the project number, title, name of the principal investigator, and a brief description of the respective project. Transitions between Problem Areas are indicated by oversized, bold text on a shaded background, with associated science categories appearing as bold text preceded by a shaded horizontal rule, as follows.

EMSP PROBLEM AREA

EMSP Science Category

Photos and illustrations are placed throughout the document to coincide with information regarding the EMSP research project to which they apply.